PATENT
ATTORNEY DOCKET NO.: 040894-5147-01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Assistant Commissioner for Patents
BOX PATENT APPLICATION
Washington, D.C. 20231

REISSUE PATENT APPLICATION TRANSMITTAL

This is a request for filing a reissue application for:

U.S. Patent No.:	5,793,793
Issue Date:	August 11, 1998
Inventors:	Wataru Matsutani and Junichi Kagawa
For:	SPARK PLUG

1. This application is for the reissue of a:

   [x] **Utility Patent** [ ] **Design Patent** [ ] **Plant Patent**

2. The papers enclosed to obtain a filing date are as follows:

   20 Pages of specification including:
   10 Pages including claims
   10 Pages including abstract/title page, description, and 3 Sheets of [ ] FORMAL [x] INFORMAL drawings containing 5 Figures
   1 Page copy of Certificate of Correction (corrections made by Certificate of Correction are incorporated into the specification and claims filed herewith).

3. Reissue Oath/Declaration and Power of Attorney

   [ ] Enclosed and is executed by all inventors.
   [x] Not Enclosed
   This application is being filed under 37 C.F.R. § 1.53(f). Applicant(s) await notification from the Patent and Trademark Office of the time set for filing the Declaration and paying the filing fees.

4. Assignment

   [x] The original U.S. Patent is assigned of record to **NGK Spark Plug Co., Ltd.** and is recorded at Reel **8665**, Frame **0203**, recorded on **June 27, 1997**.

5. Priority - foreign applications under 35 U.S.C. §119(a)-(d) or §365(b) or PCT international applications under 35 U.S.C. §365(a) designating at least one country other than the U.S.

Foreign applications from which priority is claimed are:

Country	Application No.	Filed
Japan	8-188347	June 28, 1996
Japan	8-335119	November 28, 1996

Certified copies: [ ] is/are attached.
[ ] will follow.
[x] were filed in the prior U.S. application no. **08/883,145**.

6. Fee Calculation (37 C.F.R. §1.16)

CLAIMS FOR FEE CALCULATION				
	Number Filed	Number Extra	at Rate of	Basic Fee Utility$790.00 Design $330.00
Total Claims (37 C.F.R. §1.16(c))	41 - 20 =	21	$ 22.00 each=	+ 462.00
Independent Claims (37 C.F.R. §1.16(b))	7 - 3 =	4	$ 82.00 each=	+ 328.00
Multiple dependent claim(s), if any (37 C.F.R. §1.16(d))			$270.00	+
			SUB-TOTAL =	**$ 1,580.00**
			Reduction by ½ for filing by a small entity	**- $**
			TOTAL FILING FEE =	**$ 1,580.00**

7. Small entity status is claimed and

[ ] a statement claiming small entity status is enclosed, or
[ ] a small entity statement was filed in prior application and is still proper and desired.

8. Fee Payment

[x] Not Enclosed. **NO FEE IS BEING PAID BY CHECK OR DEPOSIT ACCOUNT AT THIS TIME.**
This application is being filed under the provisions of 37 C.F.R. §1.53(f). Applicant(s) await notification from the Patent and Trademark Office of the time set for filing the Declaration and paying the filing fees.

[ ] Enclosed.
A check in the amount of $_____ representing the filing fee of a reissue application is enclosed.

9. [x] **Except** for issue fees payable under 37 C.F.R. §1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. §1.16 and §1.17 which may be required, including any required extension of time fees, or credit any overpayment to Deposit Account 50-0310. This paragraph is intended to be a **CONSTRUCTIVE PETITION FOR EXTENSION OF TIME** in accordance with 37 C.F.R. §1.136(a)(3).

10. Additional papers enclosed:

[x] Information Disclosure Statement
[x] Form PTO-1449, twenty-nine (29) references included
[x] Request to Transfer Drawings under 37 C.F.R. §1.174(a)

Please accord an application number and filing date.

Respectfully submitted,

MORGAN, LEWIS & BOCKIUS LLP

Date: February 23, 2000

By: _____
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Reg. No. 40,411

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#3

PATENT
ATTORNEY DOCKET NO. 40894-5147-01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
Wataru MATSUTANI et al.)

Reissue Application No.: 09/513,215)

Filed: February 23, 2000)

For: SPARK PLUG)

Group Art Unit: 2875

Examiner: TBA

Commissioner for Patents
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Applicants request that the above-captioned application be amended as follows:

IN THE CLAIMS:

Please add the following new claims 42-44:

-- 42. A spark plug comprising:

a central electrode;

an insulator provided exterior to the central electrode;

a main metallic shell provided exterior to the insulator;

a ground electrode coupled to one end of the main metallic shell and having another end facing the central electrode; and

an igniting portion secured to at least one of the central electrode and the ground electrode, and forming a spark discharge gap;

wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from over 10% to less than 30% wt%.

43. A spark plug according to claim 42, wherein the Ir-based alloy includes Rh in an amount ranging from 15 to 25 wt%.

44. A spark plug according to claim 42, wherein the Ir-based alloy includes Rh in a amount ranging from 18 to 22 wt%.--

REMARKS

By this Preliminary Amendment, Applicants add new claims 42 -44. Accordingly, claims 1-44 are pending in this application. Applicants respectfully submit that new claim 42-44 correspond exactly with claims 1-3 as originally issued in U.S. Patent 5,793,793 to Matsutani et al., for which the present application is a reissue application thereof. Applicants respectfully request that the above claims be considered upon initial examination of the present application.

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 13-4520. If a fee is required for an extension of time under 37 C.F.R. 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

MORGAN, LEWIS & BOCKIUS LLP

Dated: August 3, 2000

By: ______________________
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[11] **Patent Number: 5,793,793**

[45] **Date of Patent: Aug. 11, 1998**

FOREIGN PATENT DOCUMENTS

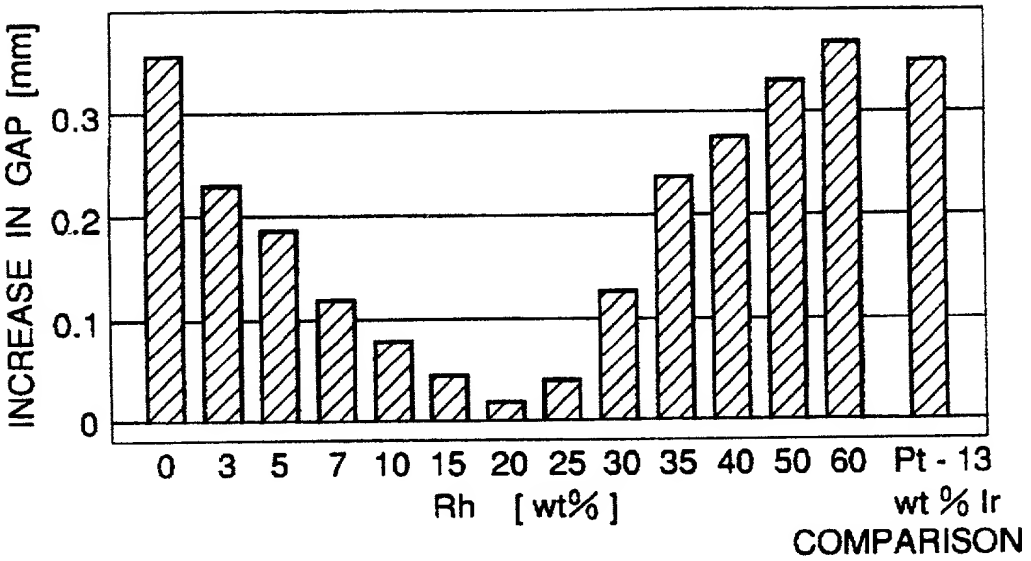
0 243 529 A1	11/1987	European Pat. Off. .
479540	2/1938	United Kingdom .
2 302 367	1/1997	United Kingdom .

Primary Examiner—Nimeshkumar Patel
Attorney, Agent, or Firm—Morgan, Lewis & Lewis

[57] **ABSTRACT**

Spark plug has a central electrode, an insulator provided exterior to the central electrode, main metallic shell provided exterior to the insulator in such a way that the central electrode protrudes from one end, and a ground electrode coupled at one end to the main metallic shell and which has the other end disposed to face the central electrode 3, with a chip being secured to either the central electrode or the ground electrode or both to form spark discharge gap g. The chip is made of a metal based on Ir which contains Rh in an amount ranging from 3 to 50 wt % (50 wt % being not inclusive).

3 Claims, 3 Drawing Sheets



SPARK PLUG

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a spark plug for use in internal combustion engines.

2. Description of the Related Art

Conventional spark plugs for use in internal combustion engines such as automotive engines have the igniting portion formed of a platinum (Pt) alloy chip welded to the tip end of an electrode in order to improve its resistance to spark consumption. However, in view of the high cost of platinum, it has been proposed to use less expensive iridium (Ir) as a chip material.

A problem with the use of Ir as a material to constitute the igniting portion of the spark plug is that Ir is easy to oxidize and evaporate in a high temperature range of 900° to 1,000° C. Therefore, if it is directly used in the igniting portion of the electrode, it is more consumed by oxidation and evaporation than by spark. Therefore, the spark plug using Ir in the igniting portion of an electrode is highly durable using low-temperature conditions as in driving on city roads but their endurance drops considerably during continuous running at high speed.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a spark plug having an igniting portion chiefly made of Ir and which yet is sufficiently resistant to consumption by oxidation and evaporation of the Ir component at elevated temperatures to assure high endurance not only during driving on city roads but also during continuous running at high speed.

A spark plug according to the present invention is comprised of: a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator, a ground electrode coupled at one end to the main metallic shell and which has the other end disposed to face the central electrode; and an igniting portion that is secured to at least one of the central electrode and the ground electrode for forming a spark discharge gap; wherein the igniting portion is made of an alloy based on Ir which contains Rh in an amount ranging from 3 to 50 wt % (50 wt % being not inclusive).

According to the present invention, the igniting portion of an electrode which forms a spark discharge gap is made of an alloy that is mainly made of Ir and which contains an amount of Rh in the stated range. Therefore, the consumption due to oxidation and evaporation of the Ir component at high temperatures is effectively retarded to thereby realize a highly durable spark plug.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a partial front sectional view of the spark plug of the invention;

FIG. 2 is a sectional view showing enlarged the essential part of the same spark plug;

FIG. 3 is a graph showing the relationship between the Rh content of the alloy forming the igniting portions of the spark plug and the increase in the spark discharge gap (in Example 1 under condition A);

FIG. 4 is a graph showing the relationship between the Rh content of the alloy forming the igniting portions of the spark plug and the increase in the spark discharge gap (in Example 1 under condition B); and

FIG. 5 is a graph showing the relationship between the Rh content of the alloy forming the igniting portions of the park plug and the increase in the spark discharge gap (in Example 1 under condition C).

DETAILED DESCRIPTION OF THE INVENTION

Detailed description of the present invention will be described as follows.

The spark plug according to the present invention has a central electrode, an insulator provided exterior to the central electrode, a main metallic shell provided exterior to the insulator, a ground electrode coupled at one end to the main metallic shell and which has the other end disposed to face the central electrode, and an igniting portion that is secured to either the central electrode or the ground electrode or both for forming a spark discharge gap, wherein the igniting portion is made of an alloy based on Ir which contains Rh in an amount ranging from 3 to 50 wt % (50 wt % being not inclusive).

The present inventors have found that if the igniting portion of an electrode which forms a spark discharge gap is made of an alloy that is mainly made of Ir and which contains an amount of Rh in the stated ranger the consumption due to oxidation and evaporation of the Ir component at high temperatures is effectively retarded to thereby realize a highly durable spark plug,

In order to form the igniting portion, a chip made of a metal having the stated composition may be joined by welding to the ground electrode and/or the central electrode. The term "igniting portion" as used herein shall refer to that part of the joined chip which has not been subject to the effect of the compositional change due to welding (e.g., the portion other than that which has been alloyed with the constituent material of the ground or central electrode upon welding),

If the Rh content of the alloy is less than 3%, the effectiveness of Rh in retarding the oxidation and evaporation of Ir is insufficient to prevent premature consumption of the igniting portion. Hence, the endurance of the spark plug is reduced. In this case, the igniting portion is consumed primarily in the tip end face of the chip welded to the central electrode and/or the ground electrode. However, the lateral sides of the chip may also be consumed if the Rh content is reduced. In such an extreme situation, the cross-sectional area of the chip through which a current is applied to cause spark discharge will decrease and the applied electric field tends to concentrate on the tip end face of the chip, whereby the consumption of the igniting portion will proceed at an accelerated rate and the life of the spark plug comes to an end prematurely. Therefore, the Rh content of the alloy is desirably adjusted to lie within such a range that the consumption of the igniting portion is unlikely to occur not only in the tip end face of the chip but also on its lateral sides. On the other hand, it the Rh content of the alloy is 50 wt % or more, the melting point of the alloy will drop and the endurance of the spark plug will deteriorate accordingly. Therefore, the Rh content of the alloy is preferably adjusted to lie within the range of 3 to 50 wt % (50 wt % being not inclusive), desirably 7 to 30 wt %, more desirably 15 to 25 wt %, most desirably 18 to 22 wt %.

Embodiments of the invention will now be described with reference to the accompanying drawings as follows.

FIG. 1 shows an embodiment of the present invention. In the drawing, a spark plug **100** has a tubular main metallic shell 1, an insulator 2 fitted into the metallic shell 1 in such

a way that the tip end **21** protrudes from the metallic shell **1**, a central electrode **3** provided within the insulator **2** in such a way that the igniting portion **31** formed at the tip end protrudes from the insulator **2**, and a ground electrode **4** coupled at one end to the main metallic shell **1** as by welding and which has the other end bent laterally such that its lateral aide faces the tip end of the central electrode **3**. The ground electrode **4** has an igniting portion **32** formed in such a way that it faces the igniting portion **31** of the central electrode **3**; the clearance between the two igniting portions **31** and **32** forms a spark discharge gap g.

The insulator **2** is a sintex of a ceramic material such as alumina or aluminum nitride as a main constituent, and it has an axial bore **6** through which the central electrode **3** is to be fitted. The main metallic shell **1** is a cylinderical form made of a metal such as a lowcarbon steel and which provides is a housing for the spark plug **100**. The circumference of the metallic shell **1** has a threaded portion **7** formed to assist in the mounting of the spark plug **100** on an engine block (not shown).

The main body **3***a* of the central electrode **3** and the main body **4***a* of the ground electrode **4** are both typically made of a Ni allloy. The igniting portion **31** of the central electrode **3** and the opposed firing portion **32** of the ground electrode **4** are both made of an alloy based on Ir and which contains Rh in an amount ranging from 3 to 50 wt % (50 wt % being not inclusive). The Rh content of the alloy is desirably adjusted to lie within a range of 7 to 30 wt %, more desirably 15 to 25 wt %, most desirably 18 to 22 wt %.

As shown in FIG. **21** the main body **3***a* of the central electrode **3** tapers at the tip end and its tip end face is formed flat A disk-shaped chip having an alloy formula for the igniting portion **31** is placed on the flat tip end face and laser welding, electron beam welding, resistance welding or other suitable welding technique is applied to the periphery of the joined surfaces to form a weld line W, whereby the chip is securely fixed to the tip end face of the central electrode **3** to form the igniting portion **31**. To form the opposed igniting portion **32**, a similar chip is placed on the ground electrode **4** in registry with the position of the igniting portion **31** and a weld line W is similarly formed on the periphery of the joined surfaces, whereby the chip is securely fitted to the ground electrode **4** to form the igniting portion **32**. The chips may be formed from a molten material obtained by mixing the necessary alloy ingredients to give the stated formula and melting the mixture, alternatively, the chips may be formed from a sinter obtained by shaping into a compact a suitable alloy powder or a mixture of the powders of elemental metal components in specified proportions and sintering the compact.

If the chips are formed of a molten alloy, a raw material made of the molten alloy may be subjected to a working process including at least one of rolling, forging, drawing, cutting, shearing and blanking steps, whereby the chips are produced in a specified shape. Steps such as rolling, forging and cutting may be performed with the alloy being heated to a specified temperature (to effect "hot" or "warm" working). The temperature for these steps which is variable with the alloy composition may typically be at least 700° C.

Stated more specifically, a molten alloy may be hot rolled to a sheet, which is hot blanked to chips of a specified shape; alternatively, the molten alloy may be hot rolled or forged to a wire or rod shape, which is cut to chips of a specified length. The iridium (Ir) which is the chief component of the chips has low ductility or malleability in its elemental form; however, in the presence of added Rh, the workability of the

Ir is improved such that the resulting alloy can be rolled or forged into a sheet, a rod or a wire with great ease compared to the case where Rh is not added. Stated specifically, defects such as cracking are less likely to occur in the raw alloy material being in the process of rolling or forging and this in turn contributes to improvements in the efficiency of chip production and the materials yield. It should be noted here that the workability of the raw alloy material will increase with increasing Rn addition.

If desired, either one of the two opposed igniting portions **31** and **32** may be omitted. If this is the case, the spark discharge gap g is formed between the igniting portion **31** (or the opposed igniting portion **32**) and the ground electrode **4** (or the central electrode **3**).

The spark plug **100** operates according to the following mode of action. The spark **100** is fitted on an engine block by means of the threaded portion **7** and used as a source to ignite an air-fuel mixture that is supplied into the combustion chamber. The igniting portion **31** and the opposed igniting portion **32** define the spark discharge gap g; since both igniting portions are made of the aforementioned alloy, their consumption due to the oxidation and evaporation of Ir is sufficiently retarded to ensure that the spark discharge gap g will not increase for a prolonged period, thereby extending the life of the spark plug **100**.

EXAMPLES

Example 1

Specified amounts of Ir and Rh were mixed and melted to prepare alloy samples containing various amounts of Rh in the range of 0 to 60 wt %, with the balance being substantially composed of Ir (comparative samples: Rh=0 and 60 wt %). The samples were hot rolled to sheets, from which disk-shaped chips measuring 0.7 mm in diameter and 0.5 mm in thickness were sliced by electrical discharge machining. A chip prepared from a molten alloy consisting of 13 wt % Ir and the balance Pt was also fabricated as a comparison. The thus fabricated chips were used to form the igniting portion **31** of the spark plug **100** and the opposed igniting portion **32** (to provide a spark discharge gap g of 1.1 mm). The individual plugs were subjected to performance tests under the following conditions.

Condition A (Simulating Continuouus Running at High Speed)

A six-cylinder gasoline engine (piston displacement=3,000 cc) was fitted with the plug under test and operated continuously at full throttle for 300 hours at a rotational speed of 6,000 rpm (with the temperature of the central electrode rising to about 900° C.); after the engine operation, the increase in the spark discharge gap g on the plug was measured. The result is shown in FIG. 3 in terms of the relationship between the Rh content of the alloy and the increase in the spark discharge gap.

Condition B (Simulating Cruising on City Roads)

A four-cylinder gasoline engine (piston displacement=2,000 cc) was fitted with the plug under test and operated for 1,000 hours through cycles, each consisting of 1-min idling, 30-min running at full throttle and a rotational speed of 3,500 rpm and 20-min running at half throttle and a rotational speed of 2,000 rpm, with the temperature of the central electrode rising to about 780° C.; after the engine operation, the increase in the spark discharge gap g on the plug was measured. The result is shown in FIG. 4 in terms

of the relationship between the Rh content of the alloy and the increase in the spark discharge gap.

The result of the test under condition B indicates that the plugs using chips made of alloy formulae within the range of the invention experienced only small increases in the spark discharge gap g whereas the comparative plugs (Rh= 60 wt %, and Pt-Ir alloy) had the spark discharge gap increased markedly. The difference of the invention samples with respect to the comparisons was more pronounced under condition A of a higher load than condition B. It is also clear from FIG. 3 that the increase in the spark discharge gap decreased stepwise as the range of the Rh content varied from that of 3 to 50 wt % to 7 to 30 wt % and then to 15 to 25 wt %; in particular, the plugs using chips containing 15 to 25 wt % of Rh exhibited a very high level of endurance in spite of the hostile operating condition.

It should also be noted that compared to a raw material that was solely composed of elemental Ir in the absence of Rh, the raw alloy materials containing 15 to 25 wt % of Rh tended to develop less cracking when the were hot rolled to sheets

Examples 2

Specified amounts of Ir and Rh were mixed and melted to prepare alloy samples containing Rh in 15, 18, 20, 22 and 25 wt %, with the balance being substantially composed of Ir. Chips were fabricated from these alloy samples and used to produce spark plugs as in Example 1. The plugs were subjected to a performance test under the following condition C which was more hostile than condition A employed in Example 1.

Condition C

A four-cylinder gasoline engine (piston displacement= 1600 cc) was fitted with the plug under test and operated

continuously at full throttle for 300 hours at a rotational speed of 6.250 rpm (with the temperature of the central electrode rising to about 950° C.); after the engine operation, the increase in the spark discharge gap g on the plug was measured. The result is shown in FIG. 5 in terms of the relationship between the Rh content of the alloy and the increase in the spark discharge gap.

It is clear from FIG. 5 that even under condition C which was more hostile than condition B. The plugs using the chips containing 18 to 22 wt % of Rh experienced smaller increases in the gap and proved to be more durable than the pugs using the chips containing Rh in amounts outside the stated range.

What is claimed is:

1. A spark plug comprising:
a central electrode;
an insulator provided exterior to the central electrode;
a main metallic shell provided exterior to the insulator;
a ground electrode having one end coupled to the main metallic shell and [coupled to one end of the main metallic shell and having] another end facing the central electrode; and
an igniting portion secured to at least one of the central electrode and the ground electrode, and forming a spark discharge gap;
wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from over 10% to less than 30% wt%.

2. The [A] spark plug according to claim 1, wherein the Ir-based alloy includes Rh in an amount ranging from 15 to 25 wt%.

3. The [A] spark plug according to claim 1, wherein the Ir-based alloy includes Rh in a amount ranging from 18 to 22 wt%.

Please add the following new claims:

4. A method for producing a spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap; said method comprising the steps of:

working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to less than 30wt% at 700°C or more by hot rolling or hot forging to a wire or rod shape;

cutting the worked alloy to a chip of a specified length; and

welding and bonding the chip as the igniting portion to at least one of the central electrode and the ground electrode.

5. A method for producing a spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap; said method comprising the steps of:

working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to less than 30wt% at 700°C or more by hot rolling to a sheet;

hot blanking the sheet to a chip of a specified shape; and

welding and bonding the chip as the igniting portion to at least one of the central electrode and the ground electrode.

6. A method for producing a spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap; said method comprising the steps of:

placing a chip including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% on a tip end face of the central electrode comprising Ni alloy; and

forming an annular welding portion laid across the chip and the central electrode, so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt%.

7. A method for producing a spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap; said method comprising the steps of:

placing a chip including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt% on a tip end face of the central electrode comprising Ni alloy; and

forming an annular welding portion laid across the chip and the central electrode, so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt%.

8. The method for producing a spark plug according to claim 6, wherein the welding portion is exposed to an outer periphery of the chip, and is not exposed to the tip end face of the chip.

9. The method for producing a spark plug according to claim 7, wherein the welding portion is exposed to an outer periphery of the chip, and is not exposed to the tip end face of the chip.

10. The method for producing a spark plug according to claim 6, wherein a taper portion is formed at a tip end side of the central electrode, and the chip is bonded to the tip end face of the taper portion so as to form the igniting portion.

11. The method for producing a spark plug according to claim 7, wherein a taper portion is formed at a tip end side of the central electrode, and the chip is bonded to the tip end face of the taper portion so as to form the igniting portion.

12. The method for producing a spark plug according to claim 10, wherein the central electrode is arranged such that the whole of the taper portion protrudes from an outside of an opening edge of a through hole of the insulator, the central electrode being inserted into the through hole.

13. The method for producing a spark plug according to claim 11, wherein the central electrode is arranged such that the whole of the taper portion protrudes from an outside of an

opening edge of a through hole of the insulator, the central electrode being inserted into the through hole.

14. The method for producing a spark plug according to claim 6, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling or hot forging to a wire or rod shape, and thereafter, cutting the worked alloy to a specified length in a longitudinal direction.

15. The method for producing a spark plug according to claim 7, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling or hot forging to a wire or rod shape, and thereafter, cutting the worked alloy to a specified length in a longitudinal direction.

16. The method for producing a spark plug according to claim 6, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling to a sheet, hot blanking the sheet to a chip of a specified shape, and welding and bonding the chip.

17. The method for producing a spark plug according to claim 7, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling to a sheet, hot blanking the sheet to a chip of a specified shape, and welding and bonding the chip.

18. The method for producing a spark plug according to claim 4, wherein the igniting portion including an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

19. The method for producing a spark plug according to claim 5, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

20. The method for producing a spark plug according to claim 6, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

21. The method for producing a spark plug according to claim 7, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

22. The method for producing a spark plug according to claim 18, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

23. The method for producing a spark plug according to claim 19, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

24. The method for producing a spark plug according to claim 20, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

25. The method for producing a spark plug according to claim 21, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

26. A spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap;

wherein a chip including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% is placed on a tip end face of the central electrode comprising Ni alloy; and

an annular welding portion laid across the chip and the central electrode is formed so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt%.

27. A spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode;

and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap;

wherein a chip including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt% is placed on a tip end face of the central electrode comprising Ni alloy; and

an annular welding portion laid across the chip and the central electrode is formed so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt%.

28. The spark plug according to claim 26, wherein the welding portion is exposed to an outer periphery of the chip, and is not exposed to the tip end face of the chip.

29. The spark plug according to claim 27, wherein the welding portion is exposed to an outer periphery of the chip, and is not exposed to the tip end face of the chip.

30. The spark plug according to claim 26, wherein a taper portion is formed at a tip end side of the central electrode, and the chip is bonded to the tip end face of the taper portion so as to form the igniting portion.

31. The spark plug according to claim 27, wherein a taper portion is formed at the tip end side of the central electrode, and the chip is bonded to the tip end face of the taper portion so as to form the igniting portion.

32. The spark plug according to claim 30, wherein the central electrode is arranged such that the whole of the taper portion protrudes from an outside of an opening edge of a through hole of the insulator, the central electrode being inserted into the through hole.

33. The spark plug according to claim 31, wherein the central electrode is arranged such that the whole of the taper portion protrudes from an outside of an opening edge of a through hole of the insulator, the central electrode being inserted into the through hole.

34. The spark plug according to claim 26, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling or hot forging to a wire or rod shape, and thereafter, cutting the worked alloy to a specified length in a longitudinal direction.

35. The spark plug according to claim 27, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling or hot forging to a wire or rod shape, and thereafter, cutting the worked alloy to a specified length in a longitudinal direction.

36. The spark plug according to claim 26, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling to a sheet, hot blanking the sheet to a chip of a specified shape, and welding and bonding the chip.

37. The spark plug according to claim 27, wherein the chip is produced by working a molten alloy including an Ir-based alloy including Rh in an amount ranging from 7wt% to 10wt% at 700°C or more by hot rolling to a sheet, hot blanking the sheet to a chip of a specified shape, and welding and bonding the chip.

38. The spark plug according to claim 26, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

39. The spark plug according to claim 27, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 15wt% to less than 25wt%.

40. The spark plug according to claim 38, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

41. The spark plug according to claim 39, wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from 18wt% to less than 22wt%.

FIG.1

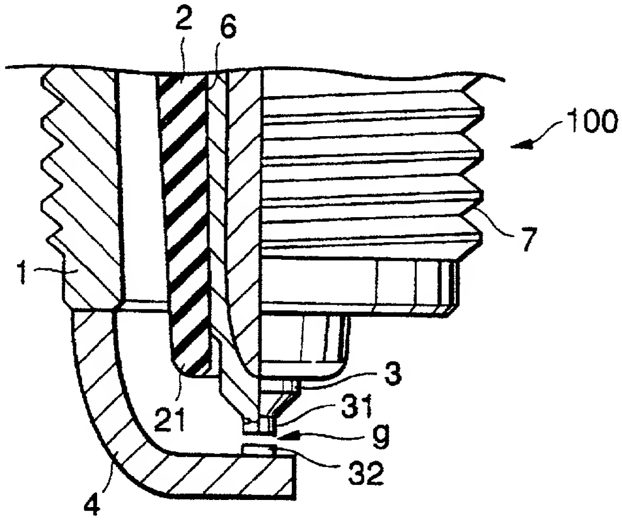


FIG.2

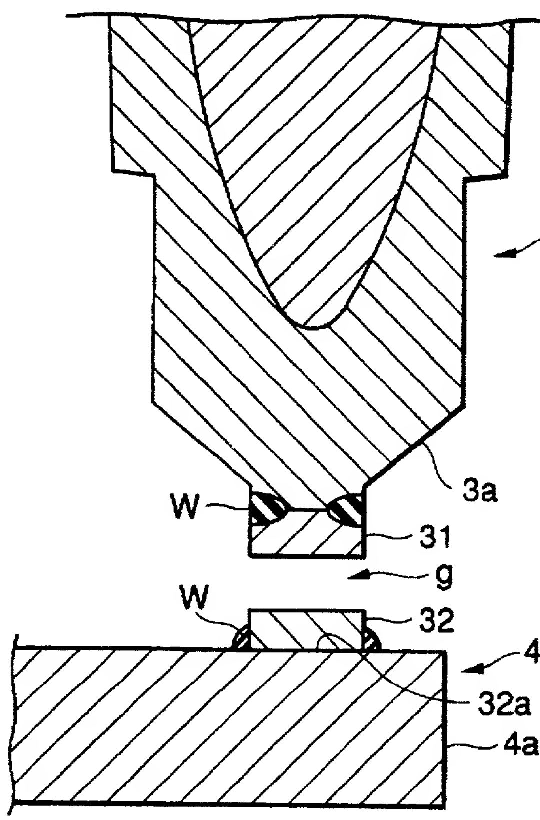


FIG.3

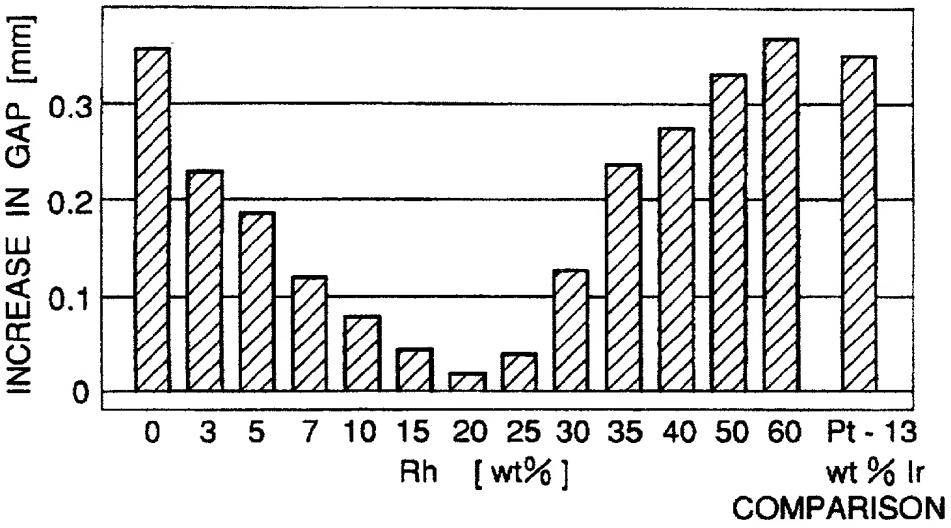

INCREASE IN GAP [mm]
0
0.1
0.2
0.3
0 3 5 7 10 15 20 25 30 35 40 50 60 Pt - 13
Rh [wt%]
wt % Ir
COMPARISON

FIG.4

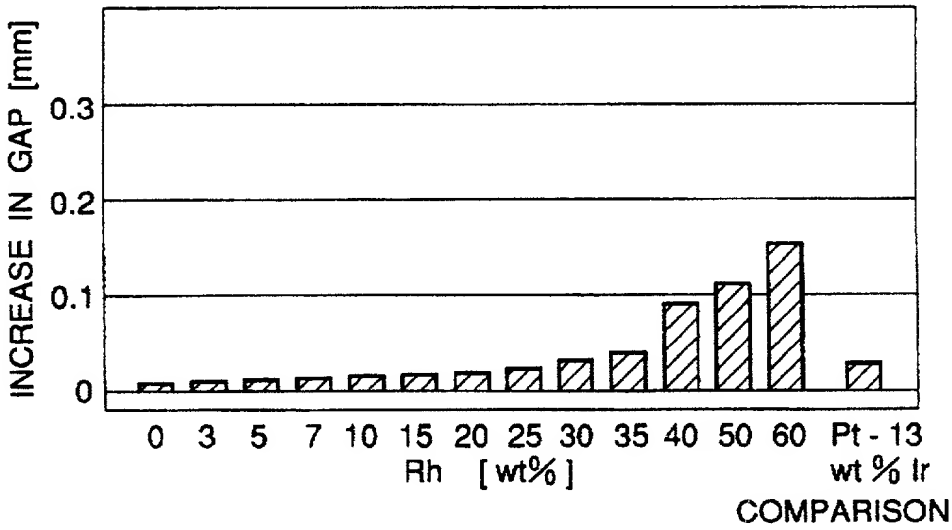
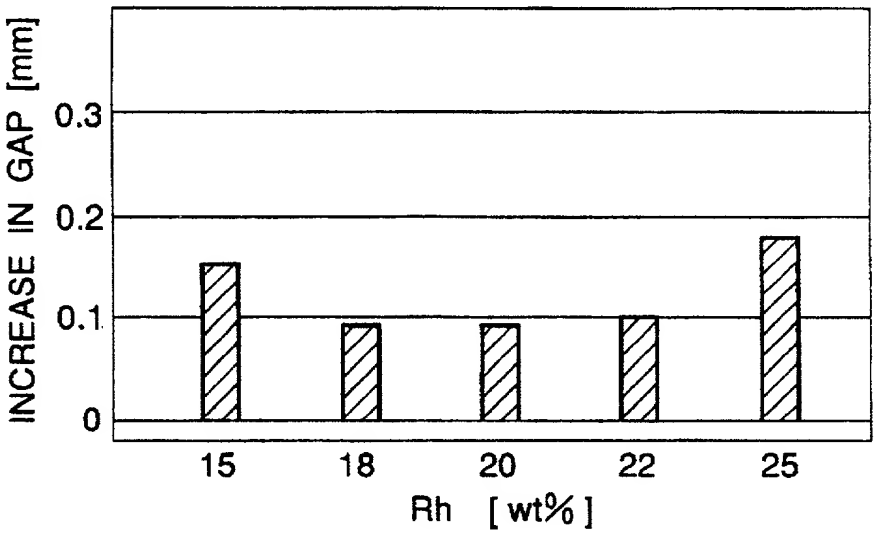

INCREASE IN GAP [mm]
0
0.1
0.2
0.3
0 3 5 7 10 15 20 25 30 35 40 50 60 Pt - 13
Rh [wt%]
wt % Ir
COMPARISON

FIG.5



#3

PATENT
ATTORNEY DOCKET NO.: 040894-5147-01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Wataru **Matsutani** and Junichi **Kagawa**

U.S. Patent No.: 5,793,793
Issue Date: August 11, 1998

Group Art Unit: Not Assigned

Reissue Application No.: 09/513,215
Filed: February 23, 2000

Examiner: Not Assigned

For: SPARK PLUG

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

REISSUE DECLARATION BY THE ASSIGNEE

1. I hereby declare that:

2. My residence, post office address and citizenship are as stated below next to my name.

3. I am authorized to act on behalf of the following company: NGK Spark Plug Co., Ltd.

4. The entire title to the patent identified below is vested in said company.

Name of Patentees:	Wataru MATSUTANI and Junichi KAGAWA
Patent Number:	5,793,793
Date Patent Issued:	August 11, 1998
Title of the Invention:	SPARK PLUG

5. I believe said patentees to be the original, first and joint inventors of the subject matter which is described and claimed in said patent, for which a reissue patent is sought on the invention entitled: **SPARK PLUG**, the specification of which

[ ] is attached hereto.
[x] was filed on February 23, 2000 as reissue application number 09/513,215, and was amended on _____.

6. I hereby claim foreign priority benefits under 35 U.S.C. § 119 on the basis of Japanese application nos. Hei 8-188347 and Hei 8-335119, filed June 28, 1996 and November 28, 1996, respectively. Certified copies were filed in the application in which the original patent was granted.

7. I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and any amendment submitted concurrently herewith.

8. I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56.

9. I verily believe the original patent to be wholly or partly inoperative or invalid by reason of (check all that apply)
[x] the patentee claiming more or less than the patentee had the right to claim in the patent.
[ ] a defective specification or drawing.

10. At least one error upon which this reissue application is based is described as follows:

Specifically, one error in the '793 patent is that the '793 patent did not include the following claim:

27. A spark plug comprising a central electrode; an insulator provided exterior to the central electrode; a main metallic shell provided exterior to the insulator; a ground electrode having one end coupled to the main metallic shell and another end facing the central electrode; and an igniting portion secured to at least one of the central electrode and the ground electrode and forming a spark plug gap;

wherein a chip including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt% is placed on a tip end face of the central electrode comprising Ni alloy; and

an annular welding portion laid across the chip and the central electrode is formed so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt%.

This claim essentially corresponds to original claim 1 of the '793 patent, but changes the claim as follows:

the original phrase "coupled to one end of the main metallic shell and having" is replaced with the new phrase --having one end coupled to the main metallic shell and--; and

the original phrase "wherein the igniting portion includes an Ir-based alloy including Rh in an amount ranging from over 10% to less than 30% wt%" is replaced with --wherein a chip including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt% is placed on a tip end face of the central electrode comprising Ni alloy; and

an annular welding portion laid across the chip and the central electrode is formed so as to form the igniting portion including an Ir-based alloy including Rh in an amount ranging from 10wt% to 25wt%--.

An error resided in that patentees were claiming less than they were entitled to in the '793 patent by including the original phrases and omitting the new phrases in claim 1.

11. All errors corrected in this reissue application arose without any deceptive intention on the part of the applicant.

12. I hereby appoint the registered practitioners of Morgan, Lewis & Bockius LLP included in the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please direct all correspondence to: **Customer Number: 009629**

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this declaration is directed.

Dated: April 27, 2000

By: S. Kanagawa

Shigenobu Kanagawa
Name of Person Signing

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